Mole Conversion Worksheet

There are three mole equalities. They are:

1 mol = 6.02×10^{23} particles
1 mol = molar mass (periodic table)
1 mol = 22.4 L for a gas at STP

Mole-Particle Conversions

1. How many moles of magnesium is 3.01×10^{22} atoms of magnesium?

3.01×10^{22} Mg atoms $\left(\frac{1 \text{ mol Mg}}{6.02 \times 10^{23} \text{ Mg atoms}}\right) = 5.00 \times 10^{-2}$ mol Mg

2. How many molecules are there in 4.00 moles of glucose, $C_6H_{12}O_6$?

4.00 moles $C_6H_{12}O_6$ $\left(\frac{6.02 \times 10^{23} \text{ molecules of } C_6H_{12}O_6}{1 \text{ mol } C_6H_{12}O_6}\right) = 2.41 \times 10^{24}$ molecules $C_6H_{12}O_6$

3. How many moles are 1.20×10^{25} atoms of phosphorous?

1.20×10^{25} P atoms $\left(\frac{1 \text{ mol P}}{6.02 \times 10^{23} \text{ P atoms}}\right) = 19.9$ mol P

4. How many atoms are in 0.750 moles of zinc?

0.750 moles Zn $\left(\frac{6.02 \times 10^{23} \text{ Zn atoms}}{1 \text{ mol Zn}}\right) = 4.52 \times 10^{23}$ Zn atoms

5. How many molecules are in 0.400 moles of N_2O_5?

0.400 mol N_2O_5 $\left(\frac{6.02 \times 10^{23} \text{ molecules } N_2O_5}{1 \text{ mol } N_2O_5}\right) = 2.41 \times 10^{23}$ molecules N_2O_5

Mole-Mass Conversions

6. How many moles in 28 grams of CO_2 ?

28 g CO_2 $\left(\frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2}\right) = 0.64$ mol CO_2

7. What is the mass of 5 moles of Fe_2O_3 ?

5 mol Fe_2O_3 $\left(\frac{159.7 \text{ g}}{1 \text{ mol } Fe_2O_3}\right) = 800$ g Fe_2O_3

8. Find the number of moles of argon in 452 g of argon.

452 g Ar $\left(\frac{1 \text{ mol Ar}}{39.95 \text{ g Ar}}\right) = 11.3$ mol Ar

9. Find the grams in 1.26×10^{-4} mol of $HC_2H_3O_2$.

1.26×10^{-4} mol $HC_2H_3O_2$ $\left(\frac{60.06 \text{ g } HC_2H_3O_2}{1 \text{ mol } HC_2H_3O_2}\right) = 7.57 \times 10^{-3}$ g $HC_2H_3O_2$

10. Find the mass in 2.6 mol of lithium bromide.

2.6 mol LiBr $\left(\frac{86.84 \text{ g LiBr}}{1 \text{ mol LiBr}}\right) = 2.3 \times 10^{2}$ g LiBr

Mole-Volume Conversions

11. Determine the volume, in liters, occupied by 0.030 moles of a gas at STP.

$0.030\ mol\left(\frac{22.4\ L}{1\ mol}\right) = 0.67\ L$

12. How many moles of argon atoms are present in 11.2 L of argon gas at STP?

$11.2\ L\ Ar\left(\frac{1\ mol\ Ar}{22.4\ L\ Ar}\right) = 0.500\ mol\ Ar$

13. What is the volume of 0.05 mol of neon gas at STP?

$0.05\ mol\ Ne\left(\frac{22.4\ L\ Ne}{1\ mol\ Ne}\right) = 1\ L$

14. What is the volume of 1.2 moles of water vapor at STP?

$1.2\ mol\ H_2O\left(\frac{22.4\ L\ H_2O}{1\ mol\ H_2O}\right) = 27\ L\ H_2O$

Molar Mass- Density Conversions (at STP)

15. What is the density of the following compounds at STP? $D = \frac{M}{V}$

a. C_2H_4 $\frac{28.06\ g\ C_2H_4}{22.4\ L\ C_2H_4} = 1.25\ g/L$

b. He $\frac{4.03\ g\ He}{22.4\ L\ He} = 0.179\ g/L$

c. CO_2 $\frac{44.01\ g\ CO_2}{22.4\ L\ CO_2} = 1.96\ g/L$

16. The density of a gas is 2.5 g/L at STP. What is the mass of this gas?

$D = \frac{M}{V}$ $M = DV$

$\frac{2.5\ g}{1\ L} \times \frac{22.4\ L}{1\ mole} = 56\ g/mole$

17. The density of a gas at STP is 0.75 g/L. What is the mass of this gas?

$\frac{0.75\ g}{L} \times \frac{22.4\ L}{1\ mole} = 17\ g/mole$

Mixed Mole Conversions

Given unit → Moles → Desired unit

18. How many oxygen molecules are in 3.36 L of oxygen gas at STP?

$3.36\ L\ O_2\left(\frac{1\ mole\ O_2}{22.4\ L\ O_2}\right)\left(\frac{6.02\times10^{23}\ O_2\ molecules}{1\ mol\ O_2}\right) = 9.03\times10^{22}\ molecules\ O_2$

19. Find the mass in grams of 2.00×10^{23} molecules of F_2.

$2.00\times10^{23}\ molecules\ F_2\left(\frac{1\ mol\ F_2}{6.02\times10^{23}\ molecules\ F_2}\right)\left(\frac{38.00\ g\ F_2}{1\ mol\ F_2}\right) = 12.6\ g\ F_2$

20. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.

$14\ g\ N_2\left(\frac{1\ mol\ N_2}{28.02\ g}\right)\left(\frac{22.4\ L}{1\ mol\ N_2}\right) = 11\ L\ N_2$

21. Find the mass, in grams, of 1.00×10^{23} molecules of N_2.

$1.00\times10^{23}\ molecules\ N_2\left(\frac{1\ mole}{6.02\times10^{23}\ molecules}\right)\left(\frac{28.02\ g}{1\ mole\ N_2}\right) = 4.65\ g\ N_2$

Percent Composition Worksheet

Find the percent compositions of all of the elements in the following compounds:

1) $CuBr_2$ = 63.55 + (2 × 79.90) = 223.35 g

Cu: $\frac{63.55}{223.35} \times 100$ = Br: $\frac{2 \times 79.90}{223.35} \times 100$

Cu: 28.45 %

Br: 71.55 %

---

2) NaOH = 23.00 + 16.00 + 1.01 = 40.01 g

Na: $\frac{23.00}{40.01} \times 100$ O: $\frac{16.00}{40.01} \times 100$

H: $\frac{1.01}{40.01} \times 100$

Na: 57.49 %

O: 39.99 %

H: 2.52 %

---

3) $(NH_4)_2S$ = (2 × 14.01) + (8 × 1.01) + 32.07 = 68.17 g

N: $\frac{(2 \times 14.01)}{68.17} \times 100$ H: $\frac{(8 \times 1.01)}{68.17} \times 100$

S: $\frac{32.07}{68.17} \times 100$

N: 41.10 %

H: 11.85 %

S: 47.05 %

---

4) N_2S_2 = (2 × 14.01) + (2 × 32.07) = 92.16 g

N: $\frac{(2 \times 14.01)}{92.16 g} \times 100$ S: $\frac{(2 \times 32.07)}{92.16} \times 100$

N: 30.40 %

S: 69.60 %

5) $KMnO_4$ = 39.10 + 54.94 + (4 × 16.00) = 158.04 g

K: $\frac{39.10}{158.04} \times 100$ Mn: $\frac{54.94}{158.04} \times 100$ O: $\frac{4 \times 16.00}{158.04} \times 100$

K: 24.74 %

Mn: 34.76 %

O: 40.50 %

---

6) HCl = 1.01 + 35.45 = 36.46 g

$\frac{1.01}{36.46} \times 100$ Cl: $\frac{35.45}{36.46}$

H: 2.77 %

Cl: 97.23 %

---

7) $Mg(NO_3)_2$ = 24.31 + (2 × 14.01) + (6 × 16.00) = 148.33 g

Mg: $\frac{24.31}{148.33} \times 100$ N: $\frac{(2 \times 14.01)}{148.33} \times 100$ O: $\frac{(6 \times 16)}{148.33} \times 100$

Mg: 16.39 %

N: 18.89 %

O: 64.72 %

---

7) $(NH_4)_3PO_4$ (3 × 14.01) + (12 × 1.01) + 30.974 + (4 × 16.00) = 149.12

N: $\frac{(3 \times 14.01)}{149.12} \times 100$ H: $\frac{(12 \times 1.01)}{149.12} \times 100$ P: $\frac{30.97}{149.12} \times 100$

O: $\frac{(4 \times 16.00)}{149.12} \times 100$

N: 28.19 %

H: 8.13 %

O: 20.77 %

P: 57.09 %

---

8) $Al_2(SO_4)_3$ = (2 × 26.98) + (3 × 32.07) + (12 × 16.00) = 342.17 g

Al: $\frac{(2 \times 26.98)}{342.17 g} \times 100$ S: $\frac{(3 \times 32.07)}{342.17 g} \times 100$ O: $\frac{(12 \times 16.00)}{342.17} \times 100$

Al: 15.77 %

S: 28.12 %

O: 56.11 %

Name: _____

Empirical Formula Practice Problems

Determine the empirical formula for the compounds below.

1.) 75% carbon, 25% hydrogen CH_4

$75\,g\,C\left(\frac{1\,mol}{12.01\,g}\right) = \frac{6.244796}{6.244796}$ $25\,g\,H\left(\frac{1\,mol}{1.01}\right) = \frac{24.75247525}{6.244796} = 3.96$

2.) 52.7% potassium, 47.3% chlorine KCl

$52.7\,g\,K\left(\frac{1\,mol\,K}{39.10\,g}\right) = \frac{1.347826}{1.334274} = 1.01$ $47.3\,g\,Cl\left(\frac{1\,mol}{35.45\,g}\right)\frac{1.334274}{1.334274} = 1$

3.) 22.1% aluminum, 25.4% phosphorus, 52.5% oxygen $AlPO_4$

$22.1\,g\,Al\left(\frac{1\,mol}{26.98\,g}\right) = \frac{0.819125}{0.819125} = 1$ $25.4\,g\,P\left(\frac{1\,mol}{30.97\,g}\right) = \frac{0.820149}{0.819125} = 1$ $52.5\,g\,O\left(\frac{1\,mol}{16.00\,g}\right)$

$\frac{3.2775}{0.819125} = 4$

4.) 13% magnesium, 87% bromine $MgBr_2$

$13\,g\,Mg\left(\frac{1\,mol}{24.31\,g}\right) = \frac{0.534757}{0.534757} = 1$ $87\,g\,Br\left(\frac{1\,mol}{79.90}\right) = \frac{1.088861}{0.534757} = 2.036217 \rightarrow 2$

Na_2SO_4

5.) 32.4% sodium, 22.5% sulfur, 45.1% oxygen

$22.5\,g\,S\left(\frac{1\,mol}{32.07}\right) = \frac{0.701590}{0.701590}$

$32.4\,g\,Na\left(\frac{1\,mol}{23.00\,g}\right) = \frac{1.408696}{0.701590} \rightarrow 2$ $45.1\,g\,O\left(\frac{1\,mol}{16.00\,g}\right) = \frac{2.81875}{0.701590} = \rightarrow 4$

6.) Freons are gaseous compounds used in refrigeration. A particular freon contains 9.93% Carbon, 59% Chlorine and 31.07% Fluorine. What is the empirical formula? CCl_2F_2

$9.93\,g\,C\left(\frac{1\,mol}{12.01\,g}\right) = \frac{0.826811}{0.826811} = 1$ $59\,g\,Cl\left(\frac{1\,mol}{35.45\,g}\right) = \frac{1.664316}{0.826811} = 2.0$ $31.07\,g\,F\left(\frac{1\,mol}{19.00\,g}\right) =$

$\frac{1.632105}{0.826811} = 1.97$

7.) A compound consists of 85% silver and 15% fluorine by mass. What is the empirical formula?

AgF

$85\,g\,Ag\left(\frac{1\,mol}{107.87\,g}\right) = \frac{0.787986}{0.787986} = 1$ $\quad 15\,g\,F\left(\frac{1\,mol}{19.00\,g}\right) = \frac{0.789474}{0.787986} = 1.001 \rightarrow 1$

8.) A compound consists of 40% calcium, 12% carbon and 48% oxygen by mass. What is the empirical formula by mass?

$CaCO_3$

$40\,g\,Ca\left(\frac{1\,mol}{40.08\,g}\right) = \frac{0.998004}{0.998004}$ $\quad 12\,g\,C\left(\frac{1\,mol}{12.01\,g}\right) = \frac{0.999167}{0.998004} = 1.0016 \rightarrow 1$ $\quad 48\,g\,O\left(\frac{1\,mol}{16.00\,g}\right) \div \frac{3}{0.998004} = 3.006 \rightarrow 3$

9.) A compound contains 50% Magnesium, 24% carbon, 10% hydrogen, and 16% oxygen. What is the empirical formula? $MgC_2H_{10}O$ → not a likely compound.

$50\,g\,Mg\left(\frac{1\,mol}{24.31\,g}\right) = 2.056767$ $\quad 24\,g\,C\left(\frac{1\,mol}{12.01\,g}\right) = 1.998334$ $\quad 16\,g\,O\left(\frac{1\,mol}{16.00\,g}\right) = 1$

$10\,g\,H\left(\frac{1\,mol}{1.01}\right) = 9.900990$

10.) Benzoic acid contains 68.8% Carbon, 4.95% Hydrogen and 26.2% Oxygen. Find the empirical formula.

$[C_{3.5}H_3O_1] \times 2$ $\quad C_7H_6O_2$

$68.8\,g\,C\left(\frac{1\,mol}{12.01\,g}\right) = \frac{5.728560}{1.6375} = 3.498$ $\quad 4.95\,g\,H\left(\frac{1\,mol}{1.01\,g}\right) = \frac{4.900990}{1.6375} = 2.992 \rightarrow 3$ $\quad 26.2\,g\,O\left(\frac{1\,mol}{16.00\,g}\right) = \frac{1.6375}{1.6375} = 1$

11.) A compound contains 25.3% copper, 12.9% sulfur, 25.7% oxygen, and 36.1% water (This formula is written as a hydrate).

$CuSO_4 \cdot 5H_2O$ (copper sulfate pentahydrate)

$25.3\,g\,Cu\left(\frac{1\,mol}{63.55\,g}\right) = \frac{0.398112}{0.398112} = 1$ $\quad 12.9\,g\,S\left(\frac{1\,mol}{32.07\,g}\right) = \frac{0.402245}{0.398112} = 1.010 \rightarrow$

$25.7\,g\,O\left(\frac{1\,mol}{16.00}\right) = \frac{1.60625}{0.398112} = 4.034 \rightarrow 4$ $\quad 36.1\,g\,H_2O\left(\frac{1\,mol}{18.02\,g}\right) = \frac{2.003330}{0.398112} = 5.03 \rightarrow 5$

.2 Chemistry Molecular formula Worksheet Name _____

1. Benzene, a non-polar solvent used for many applications in industry, and a major component in many organic compounds has the following percent composition:

C = 92.3% H = 7.8 %

a. Find Benzene's empirical formula. CH

$92.3g\left(\frac{1mol}{12.01}\right) = \frac{7.685262}{7.685262}$ $7.8gH\left(\frac{1mol}{1.01g}\right) = \frac{7.722772}{7.685262} = 1.00 \rightarrow 1$

b. Find the Molecular formula of benzene if the entire formula mass is 78.12 g/mol C_xH_y

empirical mass = 13.02g $\frac{78.12}{13.02} = 6$ C_6H_6

2. An unknown sugar is found to have a formula mass of 180.18 g/mol. The sugar contains:

40.0 % C, 6.7 % H and 53.3 % O.

a. Find the empirical and molecular formula of this sugar. b. What's its name? $C_6H_{12}O_6$ Glucose

$40.0g\left(\frac{1mol}{12.0g}\right) = \frac{3.330558}{3.330558} \rightarrow 1$ $6.7gH\left(\frac{1mol}{1.01g}\right) = \frac{6.633663}{3.330558} \rightarrow 2$ $53.3gO\left(\frac{1mol}{16.00g}\right) = \frac{3.33125}{3.330558} \rightarrow$

Empirical formula = CH_2O = 30.02g $\frac{180.18}{30.02} = 5.966 \rightarrow 6$

3. Tryptophan – the chemical in turkey that is believed to make you sleepy – has the empirical formula $C_{11}H_{12}N_2O_2$. = 204.33
Find the molecular formula if the formula mass is 204.25 g/mol.

$\frac{204.25}{204.33} = 0.9996 \rightarrow 1$ Empirical formula = molecular formula

4. Caffeine is made of 49.48 % C, 5.19% H, 16.48% O and 28.8% ~~N. Find the~~ molecular mass of Caffeine if its overall molecular mass is 194.22 g/mol $C_8H_{10}O_2N_4$

$49.48gC\left(\frac{1mol}{12.01g}\right) = \frac{4.119900}{1.03} = 3.999\text{-}74$ $5.19gH\left(\frac{1mol}{1.01g}\right) = \frac{5.138614}{1.03} \rightarrow 5$ $16.48gO\left(\frac{1mol}{16.00g}\right) = \frac{1.03}{1.03}$

$28.8gN\left(\frac{1mol}{14.01g}\right) = \frac{2.055675}{1.03} = 1.995 \rightarrow 2$ Emp = $C_4H_5ON_2$ = 97.11g $\frac{194.22}{97.11} = 2$

5. Hydrogen peroxide is 5.93 % H and 94.07 % O. Find the formula of hydrogen peroxide given it has an overall formula mass of 34 g/mol. Empirical = HO = 17.01g

$5.93gH\left(\frac{1mol}{1.01g}\right) = \frac{5.871287}{5.871287} = 1$ $94.07gO\left(\frac{1mol}{16.00g}\right) = \frac{5.879375}{5.871287} \rightarrow 1$

$\frac{34}{17.01} = 1.9988 \rightarrow 2$ H_2O_2

6. A strong oxidizing agent and rocket propellant has a % composition of 30.43% N and 69.57 % O. Find the molecular formula if its formula mass is 92.0 g/mol.

$30.43gN\left(\frac{1mol}{14.01g}\right) = \frac{2.172020}{2.172020}$ $69.57gO\left(\frac{1mol}{16.00g}\right) = \frac{4.348125}{2.172020} = 2.002 \rightarrow 2$

Empirical = NO_2 = 46.01g $\frac{92}{46} = 2$ Molecular = N_2O_4